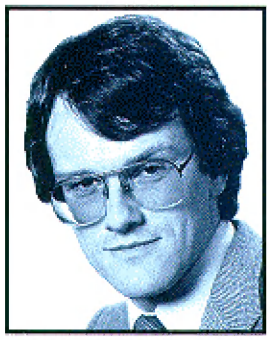
Case History

Operators prevent shaft cracks with online information

Company recovers investment in Trendmaster® 2000 in six months



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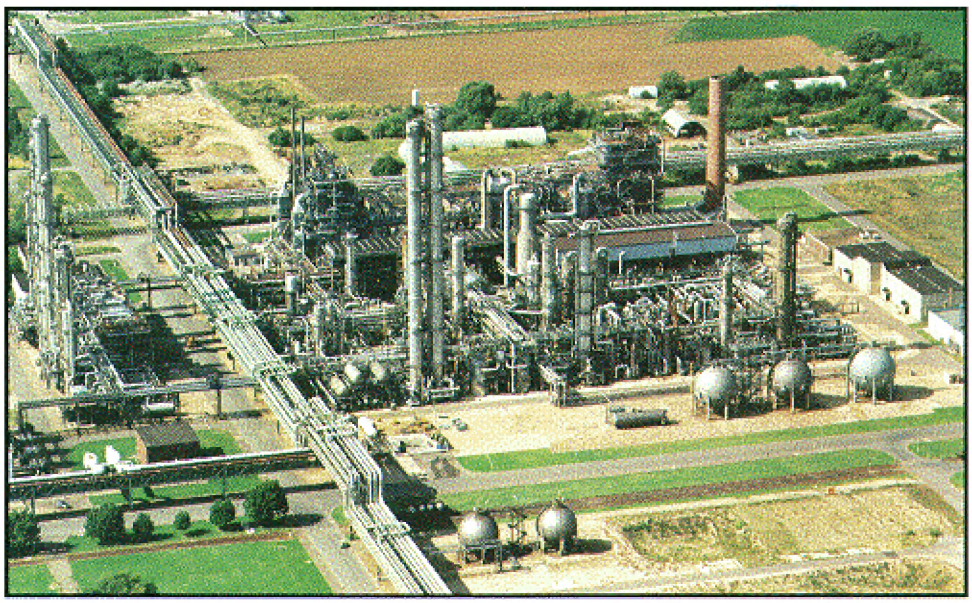

At the Rheinische Olefinwerke GmbH (ROW) petrochemical plant, we were looking for a machinery management system that would help us better understand our machines, so we could detect and eventually prevent standard failures. We wanted an intrinsically-safe system that we could install without interrupting production. Our ideal system would also have remote diagnostic capability, so our production wouldn't depend on the availability of a vibration specialist.

We chose Trendmaster® 2000. In a short time, Trendmaster 2000 has provided operators with enough information to prevent shaft cracks on our quench oil pumps. The money we have saved has paid for the system in less than six months.

The plant and process

ROW is a joint venture between BASF AG Ludwigshafen and Deutsche Shell AG Hamburg, and is located in the German city of Wesseling, near Cologne. The site is large; its 2.1 square kilometers (0.81 square miles) of plants and buildings are situated on 3.4 square kilometers (1.3 square miles) of land, and it employs 2400 people. ROW makes several different petrochemical products, of which the most important is polyethylene (708,000 tons per year). ROW makes ethylene in steamcracker plants MG4 and MG6.

For feedstock, the steamcrackers use naptha, liquified petroleum gas (LPG) and refinery gas from the Shell refinery located in the north of the ROW complex. In the MG6 steamcracker, the feedstock enters 18 furnaces, where at 840°C (1550°F) it breaks into lighter carbon gasses. This gas is first cooled to 470°C (880°F) in heat exchangers; the heat drawn off provides high-pressure steam for expansion-turbines that drive the plant's compressor sets. After it exits the heat exchangers, the carbon gas is sprayed with quench oil, which cools it to 105°C (220°F). At 105°C, some of the gas condenses; this condensate is quench oil, which is sometimes called cracker oil or cracked gas oil. Because we produce more quench oil than we use, the excess

is drawn off, while the remainder is cooled for re-use in a closed-loop system.

The remaining carbon gas is pressurized, from 120 kPa to 3600 kPa (1.2 to 36 bar), by a 35 MW cracked gas compressor. Then, the carbon gasses are separated by weight. After a precooling station, C^2 and C^3 fragments are separated. Two compressor sets, of 9 MW and 16 MW, drive coolant circuits in a coldbox that lowers the gas temperature to –153°C (–243°F), which condenses the C^2 gasses.

MG6's products are ethene (30%), pygas (24%), propene (15.0%), methane (15.0%), butadiene (9%), quench oil (4.5%) and hydrogen (1.5%).

MG6 business problems

Quench oil is pumped in the MG6 steamcracker plant by 5 centrifugal pumps driven by electric motors and small steam turbines. Each quench oil pump has a 120 mm (4.7 inch) diameter shaft that is supported by rolling element bearings and sealed with slip ring packings. From 1991 through 1993, three different quench oil pumps had shaft cracks. A cracked shaft has the potential to damage the pump's slip ring packings. If damaged, hot, flammable and toxic quench oil could be released, causing fire, serious personal injury and environmental contamination.

We also had problems with our liquid gas pumps. The pumps are specially constructed, with outer, rolling element bearings and internal slip ring packings. The packings were cooled by a water and methanol mixture, which was circulated by a thread conveyor on the surface of the pump shaft. The pumps often made a "sizzling" noise which was difficult to locate. Because we have no vibration specialist in the MG6 plant, a specialist from the ROW workshop took vibration measurements. His simple vibration detection system indicated that the problem was bearing-related. Repeatedly, we removed and dismantled the pumps, but usually found little or no bearing damage. Our liquid gas pump problems continued and became more frequent.

We needed better information if we were to prevent these recurring failures. However, we also wanted an affordable system that we could install without interrupting production. The system had to be intrinsically-safe and have remote diagnostic capability. When we began comparing machinery monitoring and management systems for general-purpose machinery, we found that Trendmaster 2000 was the only system that met all of our requirements.

Trendmaster® 2000

Trendmaster 2000 is an online machinery management system. It collects and trends data, and generates machine alarms, automatically. Each vibration or process measuring point is not continuously monitored, but is sampled at regular, short intervals. Periodic sampling lets one Trendmaster 2000 signal line carry the signals of 255 transducers, which vastly simplifies and reduces the cost of installation. Its intrinsically-safe hardware requires no explosion-proof housings. Trendmaster 2000's machinery management tools include diagnostic plot formats that make failure analysis fast and accurate. Its remote diagnostics make machine data available, via modem, over the telephone lines.

For us, Trendmaster 2000's periodic sampling was the key to affordable installation. It would have been very expensive to run new cables under the plant's concrete floor. Instead, we were able to use existing spare cables that were installed when the plant was built in 1973. We actually used Trendmaster 2000 to test the cable. Its timebase and spectrum plots showed no detectable 50 Hz noise, which can be a problem in plants such as ours.

We instrumented 48 machines in all. On each problematical machine, such as the quench oil pumps, we installed one proximity probe, one velocity probe and a Keyphasor® probe. We used velocity probes on the remaining machines. We have a remote connection from MG6 to my office. Five hundred hours of labor were needed to install the entire system, without interrupting the process.

Problems solved

Our major concern was to prevent shaft cracks on the quench oil pumps, so we monitored them closely. Trendmaster 2000's trend files highlighted subtle changes in vibration that helped solve this problem.

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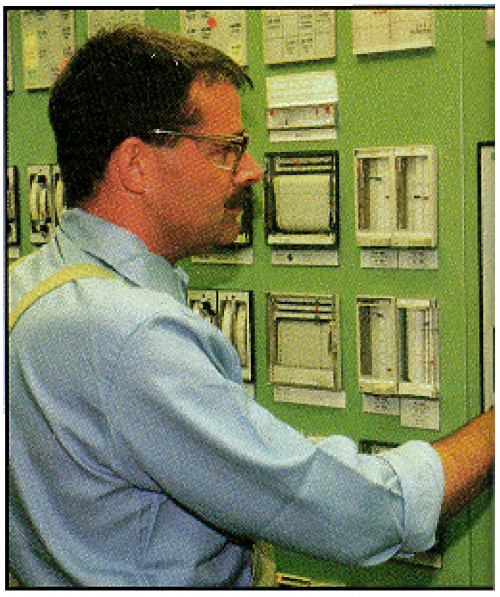
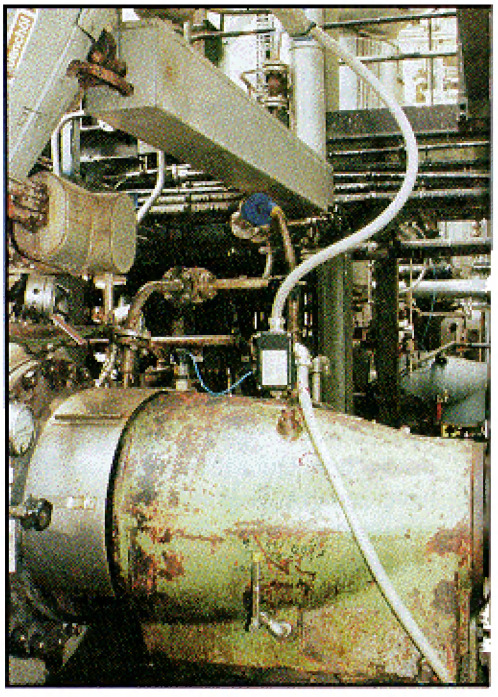


Operator accessing Trendmaster® 20 through the control room comp



Quench oil pump with Keyphasor® and Velo

pumps have had no shaft cracks tors began monitoring their with Trendmaster 2000."

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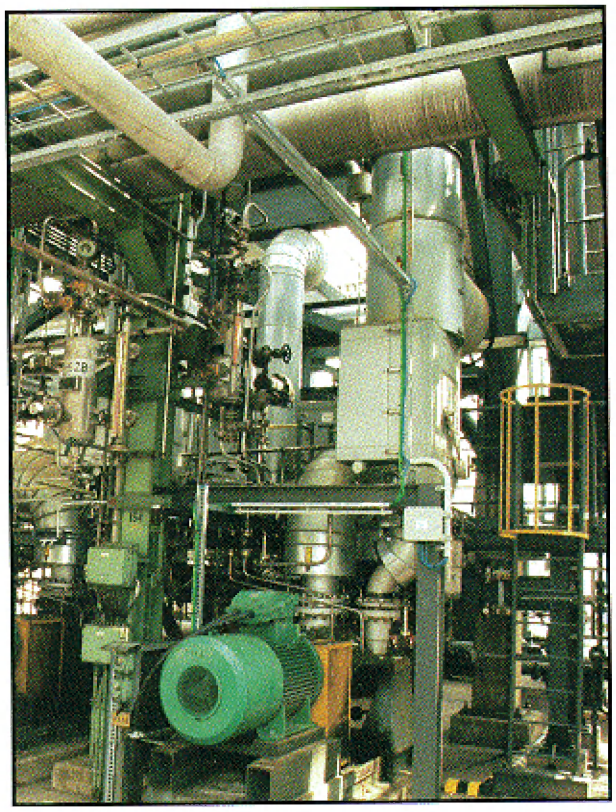
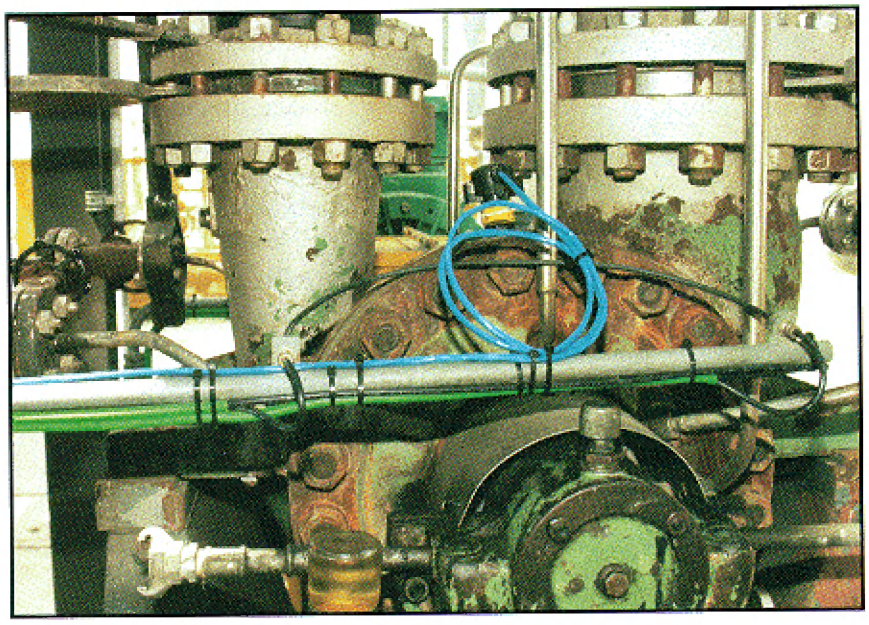


Trendmaster® 2000 installation using an iron cable tray for a neater, more cost-effective installation.

probe.



Liquid gas pump showing transducer mounting.

Quench oil pumps P-5A and P-5B operate in parallel, and each has the same differential pressure. After pump P-5B was tripped and restarted, we noticed that its overall vibration increased slightly, while pump P-5A's overall vibration decreased slightly. Although both pumps' absolute vibration levels, at less than 4 mm/s pk, were acceptable, we didn't ignore the difference between them.

We opened the intake filter on pump P-5B and removed a large amount of coke, a sediment that builds up inside the quench oil pipes. The coke had reduced the flow through the pump, making it unstable. Because we had never before measured vibration on these pumps, we had not noticed increased vibration, which must have damaged the pumps' shafts over time. We later decided that the coke had broken free when several large wedge gate valves were manually actuated.

While we were installing our Trendmaster 2000 system, we discovered the source of increased vibration on our liquid gas pumps. We actually isolated the problem with the help of a Bently Nevada Snapshot™ portable data collector. Had Trendmaster 2000 been installed, we could have acquired the same data sooner and with less labor.

The noise made by the liquid gas pumps had been misdiagnosed by ROW's vibration specialists. Their simple diagnostic equipment indicated that the noise was caused by increased vibration due to damaged bearings. The Snapshot's (and Trendmaster 2000's) more sophisticated diagnostics helped identify the problem as cavitation in the thread conveyor that circulated the water and methanol coolant to the slip ring packing. The methanol mixture, with a low vapor pressure, was susceptible to cavitation at 60 °C (140 °F). We solved the problem by changing our cooling medium from methanol to glycol.

Operators now manage machines

Now, plant operators manage the quench oil pumps in a way that minimizes damage. The pump filters still clog with coke, sometimes in as little as two weeks. However, operators now recognize that increased vibration results from reduced flow. If a pump's vibration

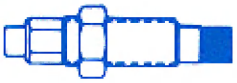
increases and the pump cannot be stopped, operators change its pressure ratio to maintain flow, in accordance with the pump's performance curve. This reduces damaging vibration without interrupting process throughput. The filter is cleaned at a later, less disruptive time.

Conclusion

Our quench oil pumps have had no shaft cracks since operators began monitoring their operation with Trendmaster 2000. Operators also use Trendmaster 2000 to monitor our liquid gas pumps, which have needed no repair in the 1 ½ years since we replaced the cooling medium. Monitoring our equipment requires much less labor, and is much more effective, with Trendmaster 2000.

We are considering an upgrade at MG6, to Trendmaster 2000 for Windows, for its network capability. We are also evaluating Trendmaster 2000 Systems for use in two other plants. We have found that Trendmaster 2000 is easy to install, easy for operators to use, that it increases plant safety and reduces the risk of environmental contamination. Most importantly, it gives us the information we need to manage our machines and process more efficiently. ***We recovered our investment in Trendmaster 2000 in less than six months.***

We recently installed a comprehensive Bently Nevada machinery management system on MG6's large compressor trains. Now, these critical machines are continuously monitored by Bently Nevada 3300 Monitoring Systems. The monitors provide both steady state and transient machine data to a Bently Nevada Transient Data Manager® 2 (TDM2) System. The TDM2 System is connected remotely to Bently Nevada's expert system, Engineer Assist™. Engineer Assist automatically analyzes the MG6 compressor trains and explains their condition in easily understood reports. With this new system, we continue extending Bently Nevada's machinery management philosophy throughout our plant. ■



ProbeTip

The advantages of redundant Keyphasor® transducers

by Tom Pfoh
Corporate Product Service Manager
Bently Nevada Corporation

Many customers now rely on Bently Nevada monitoring systems to provide much more than machinery protection. They have connected Transient Data Manager® and Dynamic Data Manager® communication processors to their monitoring systems and now rely on the system to indicate the current and future condition of their machinery.

Several pieces of information, such as 1X amplitude and phase, 2X amplitude and phase, Not 1X amplitude and machine speed, are critical for assessing machinery condition. This information is dependent on a Keyphasor® pulse.

If there is a problem with the Keyphasor transducer, the Keyphasor pulse cannot be developed and critical data is lost. The problem might be due to the failure of the transducer, the field wiring, or the transducer could even be damaged by a machine malfunction. If the Keyphasor information is lost due to a machine malfunction, you can lose your ability to diagnose the malfunction.

Many Keyphasor transducers are installed inside a machine case and may not be easily replaced. To safeguard critical data, we advise our customers to install redundant Keyphasor transducers. It may also be advantageous to install redundant Keyphasor transducers, even when the primary transducer is externally-mounted.

When installing redundant Keyphasor transducers, it is important to maintain the angular relationship of the probes, so that switching Keyphasor signals does not change the phase readings. It is also important to follow good engineering practices that would apply to any redundant transducer, such as running signal wires in separate conduits, using separate probe mounting brackets, maintaining probe tip separation, etc. It may even be a good idea to mount the Keyphasor transducers at opposite ends of the machine case to minimize the possibility that both would be destroyed during a machine malfunction.

All of the communication processors manufactured by Bently Nevada can automatically switch to the redundant Keyphasor signal if the primary Keyphasor signal is lost. This will help ensure that the critical data obtained from a Keyphasor signal is not lost.

For more information on installing Keyphasor transducers and proximity probes, please see the following two application notes:

- The Keyphasor, A necessity for Machinery Diagnosis (AN016)
- Proximity Probes and Related Accessories (AN028)

These application notes are available free from Bently Nevada and can be requested by checking the appropriate box on the Reader Service Card. ■